IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

LINEAR TECHNOLOGY CORPORATION,	)	
	)	
Plaintiff,	)	C.A. No. 06-476 (GMS)
	)	
v.	)	**PUBLIC VERSION**
	)	
MONOLITHIC POWER SYSTEMS, INC.,	)	**JURY TRIAL DEMANDED**
	)	
Defendant.	)	
	)	

MONOLITHIC POWER SYSTEMS' OPENING BRIEF IN SUPPORT OF ITS MOTION FOR SUMMARY JUDGMENT OF NO BREACH OF CONTRACT (COUNT ONE)

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OPENING BRIEF

I. NATURE AND STAGE OF THE PROCEEDING

Linear Technology Corporation ("Linear") has accused Monolithic Power Systems ("MPS") of infringing U.S. Patent Nos. 5,481,178 and 6,580,258 (the "patents-in-suit") and of breaching a settlement agreement. Trial in this proceeding is scheduled for April 28, 2008. The pre-trial conference is scheduled for April 2, 2008. Fact discovery is finished. Opening and answering expert reports have been exchanged. Expert depositions are scheduled to be concluded by December 7, 2007.

II. SUMMARY OF ARGUMENT

Count Two of Linear's complaint alleges that an MPS product, the MP1543, infringes the two patents-in-suit. Complaint, D.I. 1, ¶ 18. Count One contends that this alleged infringement constitutes a breach of the parties' September 2005 Settlement and License Agreement (the "SA," attached as Ex. A). Complaint, D.I. 1, ¶ 16. Pursuant to the SA, MPS agreed not to sell four specific products – designated the MP1556, MP1557, MP1558 and MP1559 – or any other product "in which the ZX circuitry identified by counsel for Linear in the ITC Proceeding is connected so as to allow such products to enter into what Linear referred to as 'sleep mode,' 'reverse polarity protection', or otherwise practice the Asserted Claims anywhere in the world." SA (Ex. A), ¶ 3.3.

MPS is entitled to summary judgment on Count One, as MPS's sales of the MP1543 would not constitute a breach of the SA even if the MP1543 were found to infringe the patents-in-suit. The MP1543 is not an MP1556, MP1557, MP1558 or MP1559. Indeed, it has a different topology and is designed to be used in a different type of product. The MP1543, moreover, does not contain "the ZX circuitry identified by counsel for Linear in the ITC Proceeding." Thus, MPS's sales of the MP1543 necessarily fall outside the scope of the SA. This is a legal issue for the Court to resolve. Resolving this issue now will streamline the trial, promote judicial economy and help to avoid potential prejudice and jury confusion.

MPS's sales of the MP1543 in the United States have been *de minimus*. The parties have stipulated that if Linear prevails on its patent infringement claims (Count Two) and the claims are not found to be invalid or unenforceable, MPS will pay Linear nominal patent infringement damages in the amount of $10. D.I. 88. Thus, the only significant damages issues relate to Count One.

III. LEGAL PROPOSITIONS

1. Summary judgment is appropriate "if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to summary judgment as a matter of law." Fed. R. Civ. P. 56(c); *Celotex Corp. v. Catrett*, 477 U.S. 317, 322-23 (1986).

2. Since Linear has the burden of proof at trial as to its breach of contract claim, MPS needs only to point to a lack of evidence and has no burden to disprove Linear's claim. *Celotex*, 477 U.S. at 322-24. Linear must then come forward with evidence demonstrating a genuine issue as to a material fact, and such evidence must consist of more than mere denials or assertions that a fact is challenged. *Id.* If Linear fails to make a sufficient factual showing as to any element of its case on which it bears the burden of proof at trial, the "plain language of Rule 56(c) mandates the entry of summary judgment." *Id.*, at 322.

3. The SA "is to be construed in accordance with and governed by the laws of the State of California." SA (Ex. A), ¶ 6.1.

4. Under California law, where a contract is clear on its face and not ambiguous, the Court may construe the contract and apply it as a matter of law. "The language of a contract is to govern its interpretation, if the language is clear and explicit, and does not involve an absurdity." Cal. Civ. Code § 1638 (West 1985). "[I]f the meaning a layperson would ascribe to contract language is not ambiguous, we apply that meaning." *AIU Ins. Co. v. Superior Court (FMC Corp.)*, 51 Cal. 3d 807, 821, 274 Cal. Rptr. 820, 831 (1990).

5. Under California law, "[t]he whole of a contract is to be taken together, so as to give effect to every part if reasonably practicable, each clause helping to interpret the other." Cal. Civ. Code § 1641. "Courts must interpret contractual language in a manner which gives force and effect to *every* provision, and not in a way which renders some clauses nugatory, inoperative or meaningless." *City of Atascadero v. Merrill Lynch*, 80 Cal. Rptr. 2d 329, 350, 68 Cal. App. 4th 445, 473 (1998), citing *New York Life Ins. Co. v. Hollender*, 38 Cal. 2d 73, 81-82, 237 P.2d 510 (1951). "An interpretation which renders part of an instrument to be surplusage should be avoided." *Ticor Title Ins. Co. v. Rancho Santa Fe Ass'n*, 223 Cal. Rptr. 175, 177, 177 Cal. App. 3d 726, 730 (1986).

IV. STATEMENT OF FACTS

In 2004, Linear initiated an ITC investigation, claiming that a then-shipping MPS product designated the MP1556 infringed various claims of the patents-in-suit.[1] During the ITC proceeding, Linear's attorneys and experts examined the schematics of numerous MPS voltage regulator controller products. After that process, Linear concluded that it would pursue infringement claims only as to the MP1556 and three products under development that utilized the same circuitry, *i.e.*, the MP1557, MP1558 and MP1559. Linear's attorneys presented infringement claim charts as to these products. Ex. B. Linear did not accuse the majority of MPS's voltage regulator products of infringement.

The MP1556 did not enjoy significant commercial success, which made continued litigation unappealing to MPS. In September 2005, Linear and MPS agreed to resolve their dispute by entering into the SA. Consistent with Linear's infringement contentions, the SA addressed three categories of products: (1) the MP1556, (2) the MP1557 through MP1559 products under development, and (3) "any other products in which the ZX circuitry identified by

[1] The same patents at issue in the ITC proceeding are at issue in this lawsuit. Linear, however, is asserting three claims in this lawsuit that were not included in the nine "Asserted Claims" in the ITC and identified in the SA – specifically claims 1, 3 and 34 of U.S. Patent No. 6,580,258. Even Linear appears to concede that there can be no conceivable breach of the SA with respect to those patent claims.

counsel for Linear in the ITC Proceeding is connected so as to allow such products to enter into what Linear referred to as 'sleep mode,' 'reverse polarity protection', or otherwise practice the Asserted Claims anywhere in the world." SA (Ex. A), ¶¶ 3.2, 3.3, 6.1.

In 2006, MPS began marketing a voltage regulator controller designated the MP1543. The MP1543 is a different type of controller than the MP1556-59 products. The MP1543 is designed to be used in what are called "boost" or "step-up" regulators – meaning that the output voltage of the voltage regulator is higher than its input voltage. *See* Ex. C (MP1543 datasheet). In contrast, the MP1556-59 products were designed for use in what are called "buck" or "step-down" regulators – meaning that the regulator's output voltage is lower than its input voltage. *See, e.g.,* Ex. B (MP1556 claim chart, p. 1), (MP1557 claim chart, p. 1), (MP1558 claim chart, p. 1), (MP1559 claim chart, p. 1). Thus, the MP1543 has a fundamentally different topology and intended use. Furthermore, the MP1543 does not contain "the ZX circuitry identified by counsel for Linear in the ITC Proceeding" that was present in the MP1556 through MP1559. Answering Expert Report of Defendant Monolithic Power Systems, Inc.'s Expert: Dr. Thomas Szepesi (Ex. D), at 84-87.[2] This incontrovertible fact is further demonstrated by the absence of any opinion to the contrary from Linear's expert.

V. ARGUMENT

A. MPS's Sales Of The MP1543 Would Not Constitute A Breach Of The Settlement And License Agreement, Even If Those Sales Infringed The Asserted Patent Claims

MPS and Linear entered into the SA to resolve their patent infringement dispute in the ITC. At the time the SA was executed, Linear had examined numerous MPS products and concluded that it would pursue infringement claims only as to the MP1556-MP1559 products and "any other products in which the ZX circuitry identified by counsel for Linear in the ITC

[2] While MPS has provided affirmative evidence of this fact, it had no obligation to do so. Linear has the burden of proof on its breach of contract claim. Linear produced no evidence to support the proposition that the MP1543 contains "the ZX circuitry identified by counsel for Linear in the ITC Proceeding."

Proceeding is connected so as to allow such products to enter into what Linear referred to as 'sleep mode,' 'reverse polarity protection', or otherwise practice the Asserted Claims anywhere in the world." SA (Ex. A), ¶ 3.1, 3.2, 3.3. Further, Linear expressly agreed that "MPS products, such as the MP2104, that have the accused ZX circuitry disabled . . . do not infringe the Licensed Patents." *Id.*, ¶ 3.3. Given the defined scope of this prohibition and the accused products' lack of commercial success, MPS elected to settle with Linear – but only according to the terms of the SA.

The MP1543, by definition, is not an MP1556, MP1557, MP1558 or MP1559. Given that the MP1543 is a "step-up" voltage regulator controller, it could not possibly be an MP1556-59, all of which were "step-down" regulator controllers. Linear cannot and does not dispute this.

The MP1543, furthermore, is not a product "in which the ZX circuitry identified by counsel for Linear in the ITC Proceeding is connected so as to allow such products to enter into what Linear referred to as 'sleep mode,' 'reverse polarity protection', or otherwise practice the Asserted Claims anywhere in the world." Tellingly, even though Linear bears the burden of proof on its breach of contract cause of action, its technical expert did not offer any opinion, in either his opening or his answering report, that the MP1543 contains the previously accused ZX circuitry. Indeed, neither of Linear's expert reports even contains the term "ZX," much less discusses the circuitry that had been identified by Linear's counsel in the ITC proceeding. The reason for Linear's silence is obvious – the "ZX circuitry ***identified by counsel for Linear in the ITC Proceeding***" is not present in the MP1543.

In response to MPS's position, Linear has argued that the scope of the SA actually is much broader – that it somehow precludes MPS from selling any product that infringes its patents. In order to make that argument, Linear asks the Court to ignore English grammar and, in violation of basic tenets of contract interpretation, re-write some provisions of the SA and ignore others. Linear argues that the language in the SA does not mean what it says. Instead,

Linear contends, the Court should read the phrase "or otherwise practice the Asserted Claims" out of context and in isolation from the preceding language.[3]

Linear's argument is transparently wrong – for several reasons.

First, as a matter of plain English grammar, the phrase "otherwise practice the Asserted Claims" is explicitly connected to and modified by the phrase "any other products in which the ZX circuitry identified by counsel for Linear in the ITC Proceeding is connected so as to . . . ." The expressions "sleep mode" and "reverse polarity protection" are examples of ways that the ZX circuitry could operate so as to "practice the Asserted Claims." The phrase "or otherwise practice the Asserted Claims" is a catchall to capture any other potential way that the "identified" ZX circuitry might operate to practice the Asserted Claims that did not fit neatly within the labels "sleep mode" or "reverse polarity protection."

Second, Linear's argument is wrong because it would render superfluous virtually all of paragraph 3.3 of the SA, thus violating basic tenets of contract interpretation. *See* Cal. Civ. Code § 1641 ("The whole of a contract is to be taken together, so as to give effect to every part if reasonably practicable, each clause helping to interpret the other"); *City of Atascadero*, 80 Cal. Rptr. 2d at 350, 68 Cal. App. 4th at 473 (1998) (same); *Ticor Title Ins. Co.*, 223 Cal. Rptr. at

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[3] The entirety of paragraph 3.3 reads as follows:

> MPS agrees that it has not made and will not make any sales of its MP1557-1559 products anywhere in the world. MPS further agrees that, except with respect to the Licensed Product, it has not made and will not make any sales of any other products in which the ZX circuitry identified by counsel for Linear in the ITC Proceeding **is connected so as to allow** such products to enter into what Linear referred to as **"sleep mode," "reverse polarity protection", or otherwise practice the Asserted Claims** anywhere in the world. For avoidance of doubt, Linear agrees that the MPS products, such as the MP2104, that have the accused ZX circuitry disabled as set forth in the ITC proceeding, do not infringe the Licensed Patents and that MPS may continue to make, have made, use, sell and offer to sell such products.

(emphasis added).

177, 177 Cal. App. 3d at 730 ("An interpretation which renders part of an instrument to be surplusage should be avoided").

Linear's proposed construction impermissibly would render virtually all of paragraph 3.3 to be surplusage. There would have been no point to identifying the MP1556 product, the MP1557 through MP1559 products under development, or calling out "the ZX circuitry identified by counsel for Linear in the ITC Proceeding." There also would have been no point to specifying that "MPS products . . . that have the accused ZX circuitry disabled . . . do not infringe the Licensed Patents." SA (Ex. A), ¶ 3.3. This provision immediately follows the sentence that includes the phrase "otherwise practice the Asserted Claims," which further demonstrates that the purpose and intent of the SA was to address "the accused ZX circuitry," not all possibilities of alleged patent infringement. Indeed, if Linear's argument were correct, the entirety of paragraph 3.3 – which contains 143 words – could have been written in eight words: "MPS agrees not to infringe the Asserted Claims."

Third, Linear's argument is wrong because it would require the Court to ignore the language of paragraph 6.1, which specifies that in the event of a breach of the SA, [redacted]

Thus, Linear's creative "interpretation" would require the Court to ignore plain English grammar, violate basic tenets of contract interpretation, re-write paragraph 3.3 in such a way as

to render virtually all of it surplusage and ignore the provision in paragraph 6.1 that [redacted] Linear's argument is untenable.

Linear's argument, moreover, makes no sense on a practical level. A purpose of the SA was to specify the activities that MPS agreed not to perform. MPS and Linear entered into the SA before there had been any order construing the terms of the patent claims. It would have made no sense for MPS to enter into an unbounded agreement not to practice the Asserted Claims, as such an agreement would not have provided guidance to MPS as to what activities were proscribed.[4]

The language of the SA is clear and straightforward. The MP1543: (1) is not an MP1556; (2) is not an MP1557-59; and (3) is not a product that contains "the ZX circuitry identified by counsel for Linear in the ITC Proceeding." Thus, its sales do not fall within the scope of the SA. Accordingly, the Court should grant summary judgment in favor of MPS as to Linear's breach of contract claim (Count One).

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[4] It also would have made no sense for MPS to enter into an agreement pursuant to which Linear, simply by alleging infringement, could deprive MPS of the ability to challenge validity. That is why the language of the SA is directly tied to the ZX circuitry and so clearly states that "MPS further agrees that, except with respect to the Licensed Product, it has not made and will not make any sales of any other products in which the ZX circuitry identified by counsel for Linear in the ITC Proceeding is connected so as to . . . otherwise practice the Asserted Claims anywhere in the world." That is why the SA specifies that "MPS products, such as the MP2104, that have the accused ZX circuitry disabled . . . do not infringe the Licensed Patents." The ZX circuitry has to be included and connected for there to be a breach of the SA. Neither predicate is true as to the accused MP1543 product.

VI. CONCLUSION

For the foregoing reasons, MPS respectfully requests that the Court grant its motion.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I, Kenneth L. Dorsney, hereby certify that on December 3, 2007, the attached document was electronically filed with the Clerk of the Court using CM/ECF which will send notification to the registered attorney(s) of record that the document has been filed and is available for viewing and downloading.

I further certify that on December 3, 2007, I have Electronically Mailed the document to the following person(s):

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750219

EXHIBIT A

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY

EXHIBIT B

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY

EXHIBIT C

The Future of Analog IC Technology™

MP1543

1.5A, 500KHz Synchronous Rectified Step-up Converter

DESCRIPTION

The MP1543 is a highly efficient, synchronous, fixed frequency, current-mode step-up converter with output to input disconnect, inrush current limiting and internal soft-start. It includes an error amplifier, ramp generator, comparator, N-Channel switch and P-Channel synchronous rectified switch (which greatly improves efficiency). The output disconnect feature allows the output to be completely isolated from the input in shutdown mode.

The 500KHz switching frequency allows for smaller external components producing a compact solution for a wide range of load currents. The internal compensation and soft-start minimizes the external component count and limits the inrush current during startup. The MP1543 regulates the output voltage up to 6V and provides up to 400mA from a 2-cell AA with a 3.3V output.

The MP1543 is offered in a thin SOT23-5 package.

EVALUATION BOARD REFERENCE

Board Number	Dimensions
EV1543DJ-01A	2.4"X x 2.4"Y x 0.4"Z

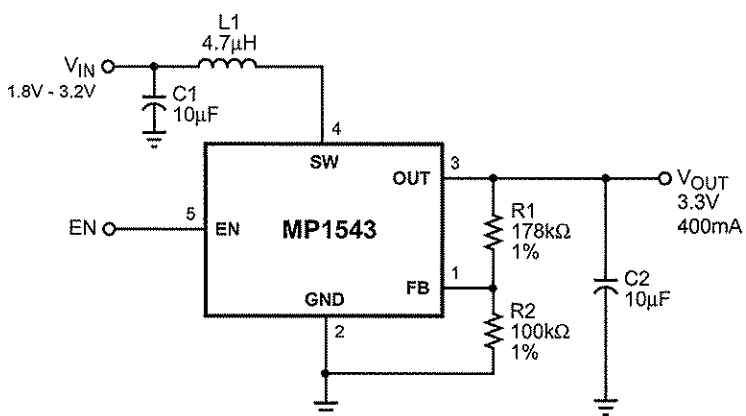
FEATURES

- Over 90% Efficiency
- Output to Input Disconnect at Shutdown Mode
- Internal Synchronous Rectifier
- Inrush Current Limiting and Internal Soft-Start
- Internal Compensation
- 1.5A Typical Switch Current Limit
- 500KHz Fixed Switching Frequency
- Zero Current Shutdown Mode
- Thermal Shutdown
- 5-Pin TSOT-23 Package

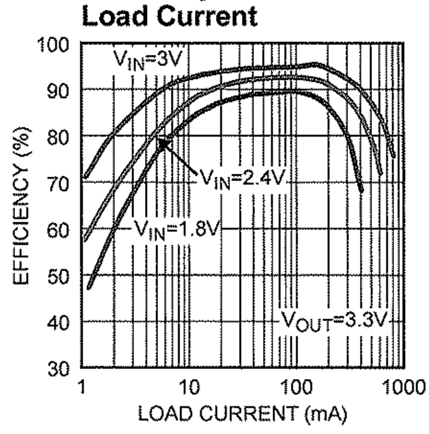
APPLICATIONS

- MP3 Players
- Handheld Computers and PDAs
- Digital Still and Video Cameras
- External Modems
- Small LCD Displays

TYPICAL APPLICATION

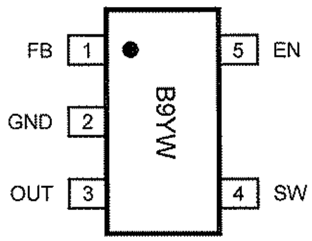


Efficiency vs Load Current



PACKAGE REFERENCE

TOP VIEW



MP1543_PD01-TSOT23-5

Part Number*	Package	Temperature
MP1543DJ	TSOT23-5	–40°C to +85°C

* For Tape & Reel, add suffix –Z (eg. MP1543DJ–Z)
For Lead Free, add suffix –LF (eg. MP1543DJ–LF–Z)

ABSOLUTE MAXIMUM RATINGS (1)

All Pins .... –0.3V to +6.5V
Storage Temperature .... –65°C to +150°C

Recommended Operating Conditions (2)

Supply Voltage V_{IN} .... 1.8V to 6V
Output Voltage V_{OUT} .... 2.5V to 6V
Operating Temperature .... –40°C to +85°C

Thermal Resistance (3) θ_{JA} θ_{JC}

TSOT23-5 .... 220 .... 110.. °C/W

Notes:
1) Exceeding these ratings may damage the device.
2) The device is not guaranteed to function outside of its operating conditions.
3) Measured on approximately 1" square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

$V_{EN} = V_{OUT} = 3.3V$, $T_A = +25°C$, unless otherwise noted.

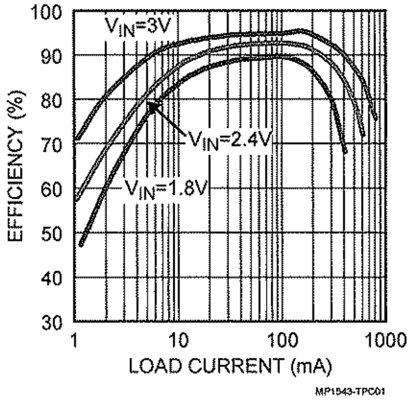
Parameter	Symbol	Condition	Min	Typ	Max	Units
Startup Supply Voltage	V_{ST}	I_{LOAD} = 0mA	1.5	1.6	1.8	V
		R_{LOAD} = 50Ω		1.7		
Output Voltage Range	V_{OUT}		2.5		6.0	V
Supply Current (Shutdown)		$V_{EN} = V_{OUT}$ 0V, V_{SW} = 5V		1		µA
Supply Current		V_{FB} = 1.3V		350		µA
Feedback Voltage	V_{FB}			1.2		V
Feedback Input Current		V_{FB} = 1.2V		50		nA
Switching Frequency	f_{SW}			500		KHz
Maximum Duty Cycle	D_{MAX}		80	85	90	%
EN Input Low Voltage					0.4	V
EN Input High Voltage			1.4			V
EN Pull Down Resistor				1		MΩ
Low-Side On Resistance	R_{ONLS}	V_{OUT} = 3.3V		300		mΩ
Low-Side Current Limit	I_{LIM}			1.5		A
High-Side On Resistance	R_{ONHS}	V_{OUT} = 3.3V		500		mΩ
Thermal Shutdown (4)				160		°C
Thermal Shutdown Hysteresis (4)				30		°C

Note:
4) Guaranteed by design, not tested.

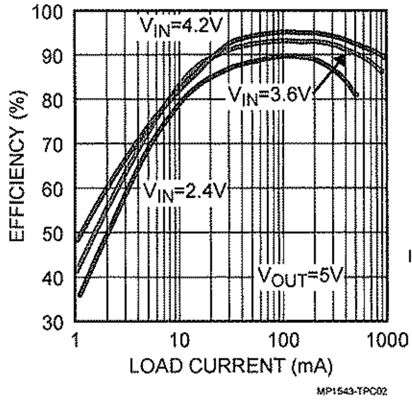
TYPICAL PERFORMANCE CHARACTERISTICS

Circuit on front page, V_{IN} = 2.4V, V_{OUT} = 3.3V, T_A = +25°C, unless otherwise noted.

Efficiency vs Load Current

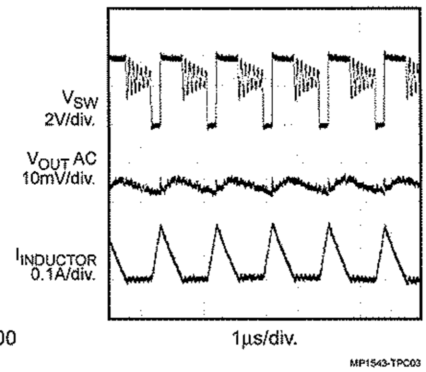


Efficiency vs Load Current



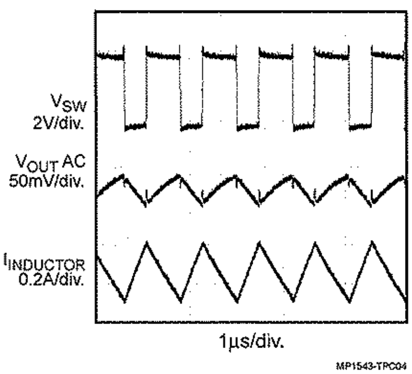
Discontinuous Mode Operation

I_{LOAD} = 25mA



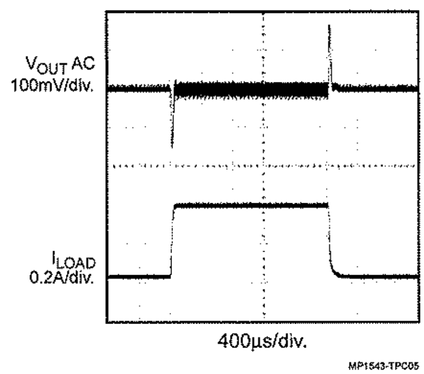
Continuous Mode Operation

I_{LOAD} = 400mA



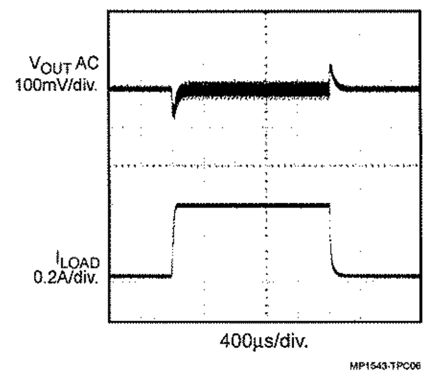
Transient Response

I_{LOAD} = 40mA to 400mA Step
w/o Feed-Forward Capacitor



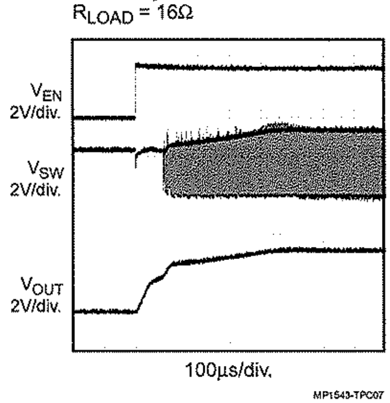
Transient Response

I_{LOAD} = 40mA to 400mA Step
with 220pF Feed-Forward Capacitor

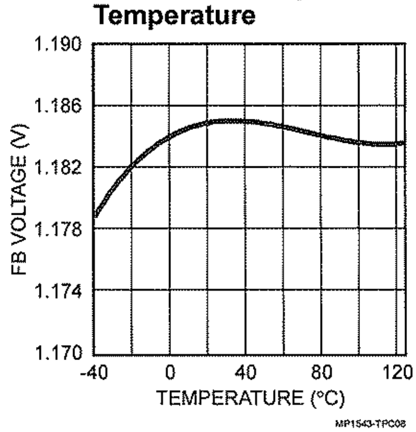


Startup

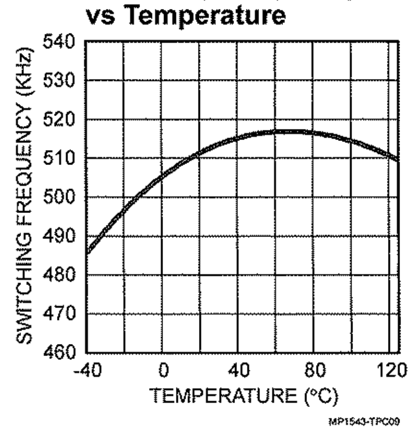
R_{LOAD} = 16Ω



Feedback Voltage vs Temperature

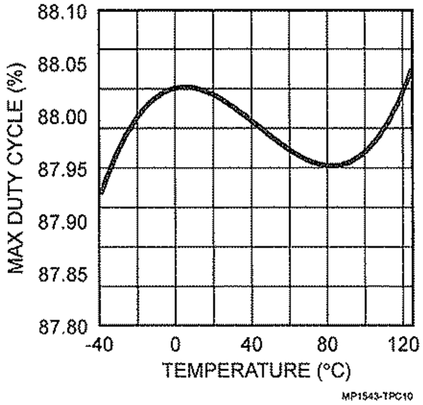


Switching Frequency vs Temperature

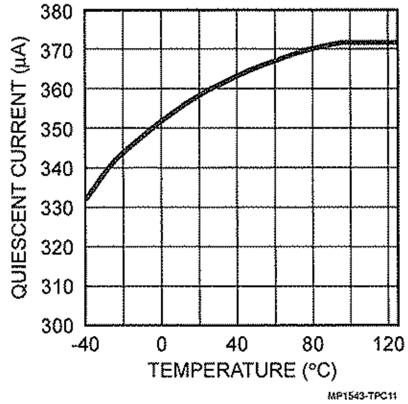


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

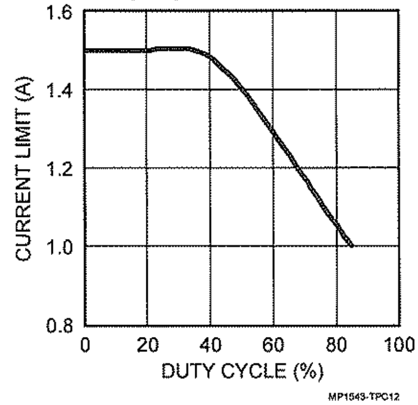
Maximum Duty Cycle vs Temperature



Quiescent Current vs Temperature



Current Limit vs Duty Cycle



PIN FUNCTIONS

Pin #	Name	Description
1	FB	Regulation Feedback Input. Connect to an external resistive voltage divider from the output to FB to set the output voltage.
2	GND	Ground.
3	OUT	Supply Input for the MP1543. Connect to the output of the converter.
4	SW	Output Switching Node. SW is the drain of the internal low-side N-Channel MOSFET and high-side P-Channel MOSFET. Connect the inductor to SW to complete the step-up converter.
5	EN	Regulator On/Off Control Input. A logic high input (V_{EN} > 1.4V) turns on the regulator. A logic low input (V_{EN} < 0.4V) puts the MP1543 into low current shutdown mode.

OPERATION

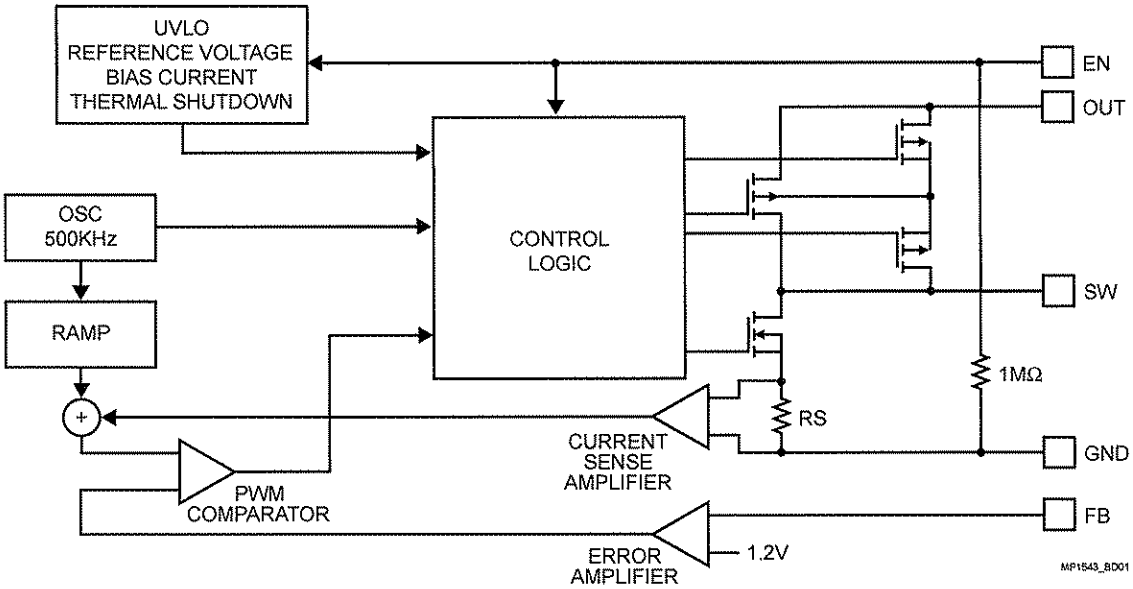


Figure 1—Functional Block Diagram

The MP1543 uses a 500KHz fixed-frequency, current-mode regulation architecture to regulate the output voltage. The MP1543 measures the output voltage through an external resistive voltage divider and compares that to the internal 1.2V reference to generate the error voltage. The current-mode regulator compares the error voltage to the inductor current to regulate the output voltage. The use of current-mode regulation improves transient response and control loop stability.

When the MP1543 is disabled (EN = Low), both power switches are off. The body of the P-Channel MOSFET connects to SW and there is no current path from SW to OUT. Therefore, the output voltage discharges to ground. When the MP1543 is enabled (EN = High), the body of the P-Channel MOSFET connects to OUT and forms a forward diode from SW to OUT. Thus the output voltage rises up toward the input voltage. When output voltage crosses 1.6V the MP1543 starts the controller and regulates the output voltage to the target value.

At the beginning of each cycle, the N-Channel MOSFET switch is turned on, forcing the inductor current to rise. The current at the source of the switch is internally measured and converted to a voltage by the current sense amplifier. That voltage is compared to the error voltage. When the inductor current rises sufficiently, the PWM comparator turns off the switch, forcing the inductor current to the output capacitor through the internal P-Channel MOSFET rectifier, which forces the inductor current to decrease. The peak inductor current is controlled by the error voltage, which in turn is controlled by the output voltage. Thus the output voltage controls the inductor current to satisfy the load.

Soft-Start

The MP1543 includes a soft-start timer that limits the voltage at the error amplifier output during startup to prevent excessive current at the input. This prevents premature termination of the source voltage at startup due to inrush current. This also limits the inductor current at startup, forcing the input current to rise slowly to the amount required to regulate the output voltage during soft-start.

APPLICATION INFORMATION

COMPONENT SELECTION

Setting the Output Voltage

Set the output voltage by selecting the resistive voltage divider ratio. The voltage divider drops the output voltage to the 1.2V feedback voltage. Use a 100kΩ resistor for R2 of the voltage divider. Determine the high-side resistor R1 by the equation:

$$R1 = \frac{V_{OUT} - V_{FB}}{\left(\frac{V_{FB}}{R2}\right)}$$

Where V_{OUT} is the output voltage, V_{FB} is the 1.2V feedback voltage and R2=100kΩ.

Selecting the Input Capacitor

An input capacitor is required to supply the AC ripple current to the inductor, while limiting noise at the input source. Multi-layer ceramic capacitors are the best choice as they have extremely low ESR and are available in small footprints. Use an input capacitor value of 4.7µF or greater. This capacitor must be placed physically close to the device.

Selecting the Output Capacitor

A single 4.7µF to 10µF ceramic capacitor usually provides sufficient output capacitance for most applications. Larger values up to 22µF may be used to obtain extremely low output voltage ripple and improve transient response. The impedance of the ceramic capacitor at the switching frequency is dominated by the capacitance, and so the output voltage ripple is mostly independent of the ESR. The output voltage ripple V_{RIPPLE} is calculated as:

$$V_{RIPPLE} = \frac{I_{LOAD}(V_{OUT} - V_{IN})}{V_{OUT} \times C2 \times f_{SW}}$$

Where V_{IN} is the input voltage, I_{LOAD} is the load current, C2 is the capacitance of the output capacitor and f_{SW} is the 500KHz switching frequency.

Selecting the Inductor

The inductor is required to force the output voltage higher while being driven by the lower input voltage. A good rule for determining the inductance is to allow the peak-to-peak ripple current to be approximately 30%-50% of the maximum input current. Make sure that the peak inductor current is below the minimum current limit at the duty cycle used (to prevent loss of regulation due to the current limit variations).

Calculate the required inductance value L using the equations:

$$L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{V_{OUT} \times f_{SW} \times \Delta I}$$

$$I_{IN(MAX)} = \frac{V_{OUT} \times I_{LOAD(MAX)}}{V_{IN} \times \eta}$$

$$\Delta I = (30\% - 50\%) I_{IN(MAX)}$$

Where $I_{LOAD(MAX)}$ is the maximum load current, ΔI is the peak-to-peak inductor ripple current and η is efficiency. For the MP1543, typically, 4.7µH is recommended for most applications. Choose an inductor that does not saturate at the peak switch current as calculated above with additional margin to cover heavy load transients and extreme startup conditions.

Selecting the Feed-Forward Capacitor
A feed-forward capacitor C3 in parallel with the high-side resistor R1 can be added to improve the output ripple at discontinuous conduction mode and the load transient response (see Figure 2). Up to 220pF for this capacitor is recommended for 3.3V output applications.

Selecting the Schottky Diode
A Schottky diode D1 in parallel with the high-side P-Channel MOSFET is necessary to clamp the SW node to a safe level for outputs of 4V or above. A 0.5A, 20V Schottky diode can be used for this purpose. See Figure 3.

LAYOUT CONSIDERATIONS

High frequency switching regulators require very careful layout for stable operation and low noise. All components must be placed as close to the IC as possible. All feedback components must be kept close to the FB pin to prevent noise injection on the FB pin trace. The ground return of C1 and C2 should be tied close to the GND pin. See the MP1543 demo board layout for reference.

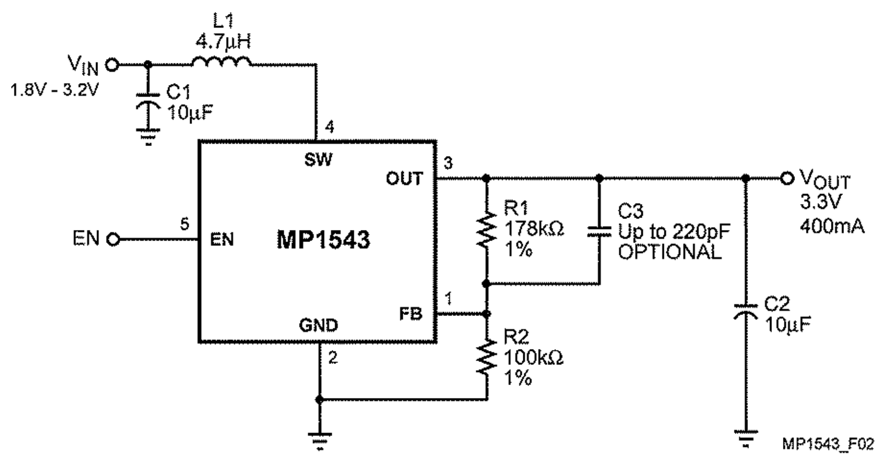


Figure 2—3.3V Typical Application Circuit with Feed-Forward Capacitor

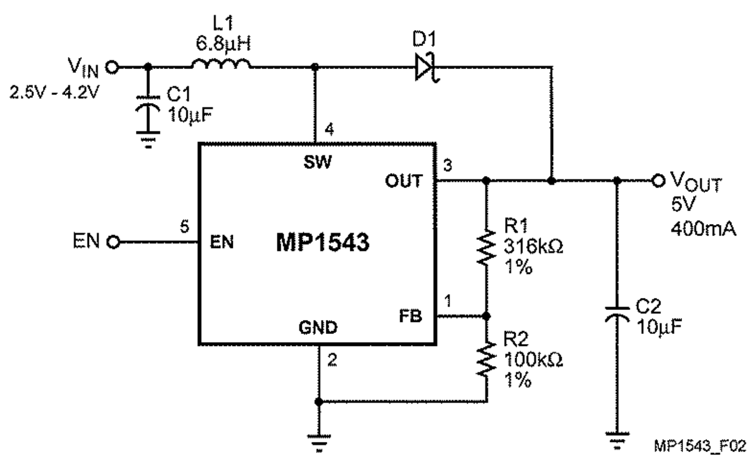


Figure 3—5V Typical Application Circuit with External Schottky Diode and Output Disconnect Not Required

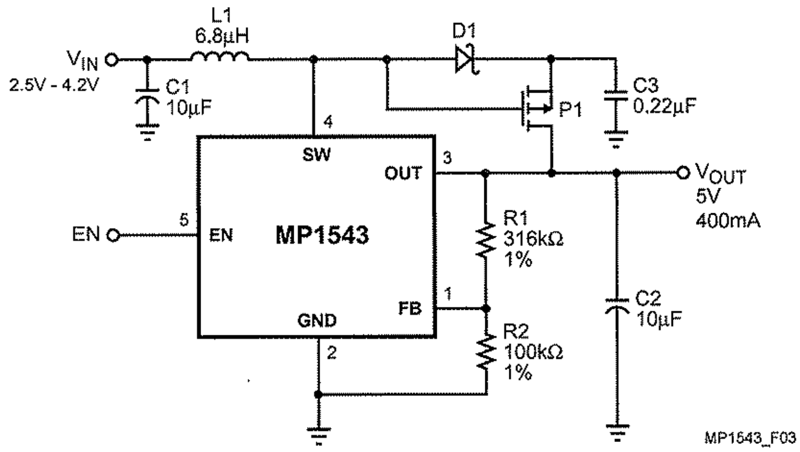
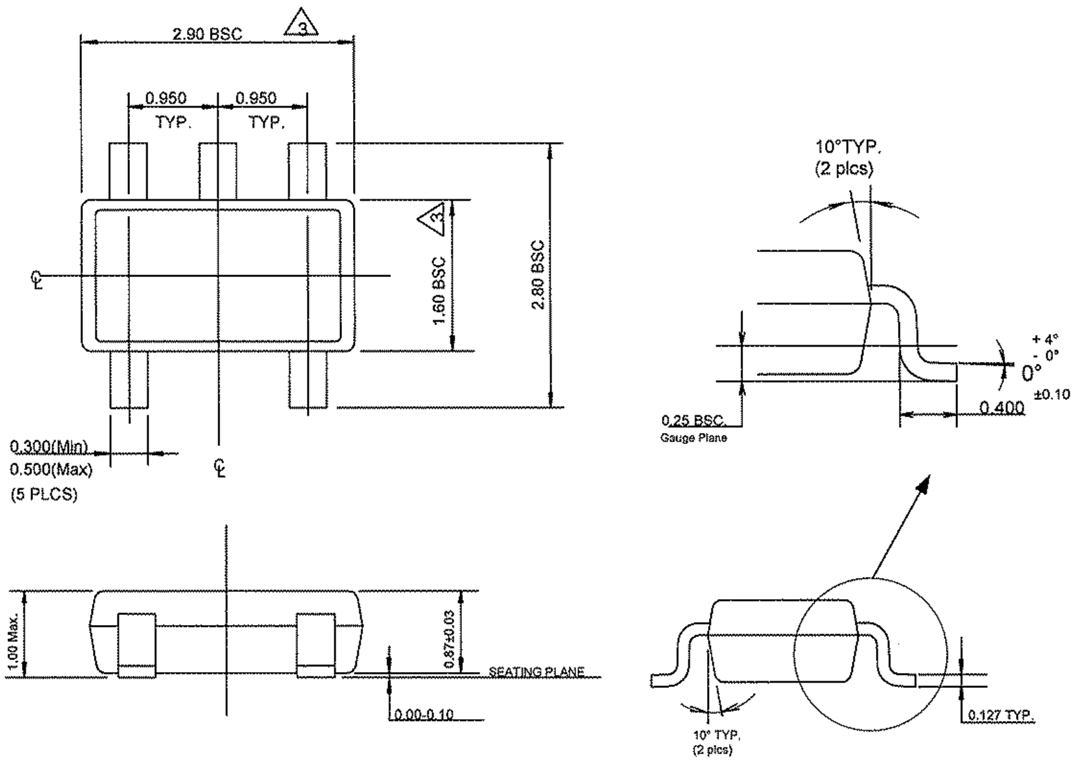


Figure 4—5V Typical Application Circuit with External Schottky Diode and Output Disconnect Required

PACKAGE INFORMATION

TSOT23-5



Dimensions are in millimeters

NOTE:

1. Dimensions and tolerances are as per ANSI Y14.5M, 1994.
2. Die is facing up for mold. Die is facing down for trim/form, ie. reverse trim/form.
3. Dimensions are exclusive of mold flash and gate burr.
4. The footlength measuring is based on the gauge plane method.
5. All specification comply to Jedec Spec MO193 Issue C.

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EXHIBIT D

THIS EXHIBIT HAS BEEN REDACTED IN ITS ENTIRETY